What is claimed is:

1. A method for target detection and identification, comprising the steps of:

(a) receiving a hyperspectral image cube, wherein said hyperspectral image cube represents a scene in terms of wavelength and spatial position;

(b) selecting a material of interest from a target database, wherein said material of interest represents a target for a target detection and identification;

(c) selecting a trial pixel having a predetermined location in said hyperspectral image cube, wherein said target detection and identification is performed on said trial pixel;

(d) building a set of reference signatures which comprises a signature of said selected material of interest and a plurality of signatures of a plurality neighboring pixels of said selected trial pixel; and

(e) applying an abundance estimator to perform an abundance estimation using measurement data corresponding to said selected trial pixel and said set of reference signatures.

2. A method for target detection and identification, as recited in claim 1, wherein in the step (d), said neighboring pixels include a left pixel of said selected trial pixel, a top pixel of said selected trial pixel, a right pixel of said selected trial pixel, and a bottom pixel of said selected trial pixel.

3. A method for target detection and identification, as recited in claim 2, wherein in the step (d), said neighboring pixels further include a left-top corner pixel of said selected trial pixel, a right-top corner pixel of said selected trial pixel, a right-bottom corner pixel of said selected trial pixel, and a left-bottom corner pixel of said selected trial pixel.

4. A method for target detection and identification, as recited in claim 1, wherein said abundance estimator is a maximum likelihood estimator.

5. A method for target detection and identification, as recited in claim 1, wherein said abundance estimator is a least square estimator.

6. A method for target detection and identification, as recited in claim 1, wherein said abundance estimator is an evolutionary estimator.

7. A method for target detection and identification, as recited in claim 6, wherein the step (e) further comprises the steps of:

(e-1) generating randomly an initial population of abundance strings by an initial population generation module that represents said abundance estimation related to said selected trial pixel of said hyperspectral image cube, wherein said abundance strings are normalized that the sum of said abundance estimation equal to 1;

(e-2) performing selection and coupling in a selection and coupling module based on a cost function by a selection and coupling module, wherein said cost function is mean square error and a criteria for best abundance string is an abundance string with minimum mean square error, wherein said abundance strings with large fitness have a large number of copies in a next generation. and once said abundance strings are selected for possible use in said next generation, said abundance strings wait an action of two other operators, namely a crossover and a mutation;

(e-3) generating a population of offspring by exchanging tails and heads of said abundance strings in a crossover module, wherein said crossover provides a mechanism for said abundance strings to mix and match desirable qualities thereof through a random process comprising the steps of selecting and coupling two said abundance strings by said selection and coupling module, selecting a position along the two strings uniformly at random, exchanging all characters following a crossing sit, and normalizing new reproduced abundance strings;

(e-4) adding numbers, which are randomly generated, to each element of each member of said population of offspring in a mutation module;

(e-5) computing a fitness value on each said abundance estimation by a fitness evaluation module, wherein a cost function takes said abundance string and returns a value, wherein said value of said cost function is then mapped into a fitness value so as to fit into said evolutionary estimator, wherein said fitness value is a reward based on a performance of a possible solution represented by said abundance string; wherein said fitness values are sent to a discriminator;

(e-6) performing a discrimination to determine whether to stop evolution or not, wherein a discrimination criteria is defined as a number of total evolution generations that, when said evolutionary estimator iterates to said number of total evolution generations, one of said abundance strings with highest fitness is selected as solution and said evolutionary algorithm quit evolution, wherein a corresponding abundance estimation vector thereof is said abundance estimate of said selected trial pixel;

(e-7) sending said new population of said abundance strings to said selection and coupling module; and

(e-8) repeating the steps (e-2), e-(3), (e-4), (e-5), (e-6), and (e-7).

8. A method for target detection and identification, as recited in claim 6, wherein the step (e) further comprises the steps of:

(e-1) generating randomly an initial population of abundance strings by an initial population generation module that represents said abundance estimation related to said selected trial pixel of said hyperspectral image cube, wherein said abundance strings are normalized that the sum of said abundance estimation equal to 1;

(e-2) performing selection and coupling in a selection and coupling module based on a cost function by a selection and coupling module, wherein said cost function is mean square error and a criteria for best abundance string is an abundance string with minimum mean square error, wherein said abundance strings with large fitness have a

large number of copies in a next generation, and once said abundance strings are selected for possible use in said next generation, said abundance strings wait an action of two other operators, namely a crossover and a mutation;

(e-3) generating a population of offspring by exchanging tails and heads of said abundance strings in a crossover module, wherein said crossover provides a mechanism for said abundance strings to mix and match desirable qualities thereof through a random process comprising the steps of selecting and coupling two said abundance strings by said selection and coupling module, selecting a position along the two strings uniformly at random, exchanging all characters following a crossing sit, and normalizing new reproduced abundance strings;

(e-4) adding numbers, which are randomly generated, to each element of each member of said population of offspring in a mutation module;

(e-5) computing a fitness value on each said abundance estimation by a fitness evaluation module, wherein a cost function takes said abundance string and returns a value, wherein said value of said cost function is then mapped into a fitness value so as to fit into said evolutionary estimator, wherein said fitness value is a reward based on a performance of a possible solution represented by said abundance string; wherein said fitness values are sent to a discriminator;

(e-6) performing a discrimination to determine whether to stop evolution or not, wherein said discrimination is performed by evaluating a difference between said abundance strings, wherein when said different between said abundance string is less than a preset value, then said evolutionary estimator quit evolution, wherein one of said abundance strings with highest fitness is chosen as a solution, a corresponding abundance estimation vector thereof is said abundance estimate of said selected trial pixel; and

(e-7) sending said new population of said abundance strings to said selection and coupling module; and

(e-8) repeating the steps (e-2), e-(3), (e-4), (e-5), (e-6), and (e-7).

9. A method for target detection and identification, as recited in claim 2, wherein said abundance estimator is an evolutionary estimator.

10. A method for target detection and identification, as recited in claim 9, wherein the step (e) further comprises the steps of:

(e-1) generating randomly an initial population of abundance strings by an initial population generation module that represents said abundance estimation related to said selected trial pixel of said hyperspectral image cube, wherein said abundance strings are normalized that the sum of said abundance estimation equal to 1;

(e-2) performing selection and coupling in a selection and coupling module based on a cost function by a selection and coupling module, wherein said cost function is mean square error and a criteria for best abundance string is an abundance string with minimum mean square error, wherein said abundance strings with large fitness have a large number of copies in a next generation, and once said abundance strings are selected for possible use in said next generation, said abundance strings wait an action of two other operators, namely a crossover and a mutation;

(e-3) generating a population of offspring by exchanging tails and heads of said abundance strings in a crossover module, wherein said crossover provides a mechanism for said abundance strings to mix and match desirable qualities thereof through a random process comprising the steps of selecting and coupling two said abundance strings by said selection and coupling module, selecting a position along the two strings uniformly at random, exchanging all characters following a crossing sit, and normalizing new reproduced abundance strings;

(e-4) adding numbers, which are randomly generated, to each element of each member of said population of offspring in a mutation module;

(e-5) computing a fitness value on each said abundance estimation by a fitness evaluation module, wherein a cost function takes said abundance string and returns a value, wherein said value of said cost function is then mapped into a fitness value so as to fit into said evolutionary estimator, wherein said fitness value is a reward based on a

performance of a possible solution represented by said abundance string; wherein said fitness values are sent to a discriminator;

(e-6) performing a discrimination to determine whether to stop evolution or not, wherein a discrimination criteria is defined as a number of total evolution generations that, when said evolutionary estimator iterates to said number of total evolution generations, one of said abundance strings with highest fitness is selected as solution and said evolutionary algorithm quit evolution, wherein a corresponding abundance estimation vector thereof is said abundance estimate of said selected trial pixel;

(e-7) sending said new population of said abundance strings to said selection and coupling module; and

(e-8) repeating the steps (e-2), e-(3), (e-4), (e-5), (e-6), and (e-7).

11. A method for target detection and identification, as recited in claim 9, wherein the step (e) further comprises the steps of:

(e-1) generating randomly an initial population of abundance strings by an initial population generation module that represents said abundance estimation related to said selected trial pixel of said hyperspectral image cube, wherein said abundance strings are normalized that the sum of said abundance estimation equal to 1;

(e-2) performing selection and coupling in a selection and coupling module based on a cost function by a selection and coupling module. wherein said cost function is mean square error and a criteria for best abundance string is an abundance string with minimum mean square error, wherein said abundance strings with large fitness have a large number of copies in a next generation, and once said abundance strings are selected for possible use in said next generation, said abundance strings wait an action of two other operators, namely a crossover and a mutation;

(e-3) generating a population of offspring by exchanging tails and heads of said abundance strings in a crossover module, wherein said crossover provides a mechanism for said abundance strings to mix and match desirable qualities thereof through a random

process comprising the steps of selecting and coupling two said abundance strings by said selection and coupling module, selecting a position along the two strings uniformly at random, exchanging all characters following a crossing sit, and normalizing new reproduced abundance strings;

(e-4) adding numbers, which are randomly generated, to each element of each member of said population of offspring in a mutation module;

(e-5) computing a fitness value on each said abundance estimation by a fitness evaluation module, wherein a cost function takes said abundance string and returns a value, wherein said value of said cost function is then mapped into a fitness value so as to fit into said evolutionary estimator, wherein said fitness value is a reward based on a performance of a possible solution represented by said abundance string; wherein said fitness values are sent to a discriminator;

(e-6) performing a discrimination to determine whether to stop evolution or not, wherein said discrimination is performed by evaluating a difference between said abundance strings, wherein when said different between said abundance string is less than a preset value, then said evolutionary estimator quit evolution, wherein one of said abundance strings with highest fitness is chosen as a solution, a corresponding abundance estimation vector thereof is said abundance estimate of said selected trial pixel; and

(e-7) sending said new population of said abundance strings to said selection and coupling module; and

(e-8) repeating the steps (e-2), e-(3), (e-4), (e-5), (e-6), and (e-7).

12. A method for target detection and identification, as recited in claim 3, wherein said abundance estimator is an evolutionary estimator.

13. A method for target detection and identification, as recited in claim 12, wherein the step (e) further comprises the steps of:

(e-1) generating randomly an initial population of abundance strings by an initial population generation module that represents said abundance estimation related to said selected trial pixel of said hyperspectral image cube, wherein said abundance strings are normalized that the sum of said abundance estimation equal to 1;

(e-2) performing selection and coupling in a selection and coupling module based on a cost function by a selection and coupling module, wherein said cost function is mean square error and a criteria for best abundance string is an abundance string with minimum mean square error, wherein said abundance strings with large fitness have a large number of copies in a next generation, and once said abundance strings are selected for possible use in said next generation, said abundance strings wait an action of two other operators, namely a crossover and a mutation;

(e-3) generating a population of offspring by exchanging tails and heads of said abundance strings in a crossover module, wherein said crossover provides a mechanism for said abundance strings to mix and match desirable qualities thereof through a random process comprising the steps of selecting and coupling two said abundance strings by said selection and coupling module, selecting a position along the two strings uniformly at random, exchanging all characters following a crossing sit, and normalizing new reproduced abundance strings;

(e-4) adding numbers, which are randomly generated, to each element of each member of said population of offspring in a mutation module;

(e-5) computing a fitness value on each said abundance estimation by a fitness evaluation module, wherein a cost function takes said abundance string and returns a value, wherein said value of said cost function is then mapped into a fitness value so as to fit into said evolutionary estimator, wherein said fitness value is a reward based on a performance of a possible solution represented by said abundance string; wherein said fitness values are sent to a discriminator;

(e-6) performing a discrimination to determine whether to stop evolution or not, wherein a discrimination criteria is defined as a number of total evolution generations that, when said evolutionary estimator iterates to said number of total evolution

generations, one of said abundance strings with highest fitness is selected as solution and said evolutionary algorithm quit evolution, wherein a corresponding abundance estimation vector thereof is said abundance estimate of said selected trial pixel;

(e-7) sending said new population of said abundance strings to said selection and coupling module; and

(e-8) repeating the steps (e-2), e-(3), (e-4), (e-5), (e-6), and (e-7).

14. A method for target detection and identification, as recited in claim 12, wherein the step (e) further comprises the steps of:

(e-1) generating randomly an initial population of abundance strings by an initial population generation module that represents said abundance estimation related to said selected trial pixel of said hyperspectral image cube, wherein said abundance strings are normalized that the sum of said abundance estimation equal to 1;

(e-2) performing selection and coupling in a selection and coupling module based on a cost function by a selection and coupling module, wherein said cost function is mean square error and a criteria for best abundance string is an abundance string with minimum mean square error, wherein said abundance strings with large fitness have a large number of copies in a next generation. and once said abundance strings are selected for possible use in said next generation, said abundance strings wait an action of two other operators, namely a crossover and a mutation;

(e-3) generating a population of offspring by exchanging tails and heads of said abundance strings in a crossover module, wherein said crossover provides a mechanism for said abundance strings to mix and match desirable qualities thereof through a random process comprising the steps of selecting and coupling two said abundance strings by said selection and coupling module, selecting a position along the two strings uniformly at random, exchanging all characters following a crossing sit, and normalizing new reproduced abundance strings;

(e-4) adding numbers, which are randomly generated, to each element of each member of said population of offspring in a mutation module;

(e-5) computing a fitness value on each said abundance estimation by a fitness evaluation module, wherein a cost function takes said abundance string and returns a value, wherein said value of said cost function is then mapped into a fitness value so as to fit into said evolutionary estimator, wherein said fitness value is a reward based on a performance of a possible solution represented by said abundance string; wherein said fitness values are sent to a discriminator;

(e-6) performing a discrimination to determine whether to stop evolution or not, wherein said discrimination is performed by evaluating a difference between said abundance strings, wherein when said different between said abundance string is less than a preset value, then said evolutionary estimator quit evolution, wherein one of said abundance strings with highest fitness is chosen as a solution, a corresponding abundance estimation vector thereof is said abundance estimate of said selected trial pixel; and

(e-7) sending said new population of said abundance strings to said selection and coupling module; and

(e-8) repeating the steps (e-2), e-(3), (e-4), (e-5), (e-6), and (e-7).

15. A method for target detection and identification, as recited in claim 6, wherein said evolutionary estimator comprises a cost function module, an initial population generation module, a selection and coupling module, a crossover module, a mutation module, a fitness evaluation module, and a discriminator, wherein

said initial population generation module creates a predetermined number of initial parent strings of an abundance, wherein a random number generator is utilized to produce uniform numbers between 0 and 1, which guarantees that values of elements of an abundance vector are between 0 and 1 and, in order to make a total abundance of each of said parent strings of abundance equal to 1.0, each of said elements of said abundance

vector of each said parent string is normalized, wherein said generated parent strings of abundance are sent to said selection and coupling module;

said cost function module, which is a mean square error, for evaluating a population of said abundance;

said selection and coupling module receives said population of said abundance and selects two of said parent strings based on said cost function module, that is a minimum value of said mean square error, wherein said two selected parent strings are sent to said crossover module to perform crossover operation;

said crossover module chooses a split point for both of said selected parent strings, wherein when said split point is located between a second and third elements, after said crossover, two new strings are created, wherein after crossover, said new strings are normalized to make a sum of said abundances equal to 1, wherein when said new strings are better than any of said parent strings in said population, said new strings replace said two selected parent strings to form survived strings and enter a new population; otherwise, said parent strings are inherited to form said survived strings, wherein said survived strings are sent to said mutation module;

said mutation module mutates each said parent string into a child string by generating −10% to 10% random numbers to add to said elements for each of said parent strings, wherein each of said survived strings is normalized and then sent to said fitness evaluation module;

said fitness evaluation module calculates said mean square error for each of said new strings, wherein when a value of mean square error of said new string is better than that of said respective parent string, said new string goes into said new population as said child string; otherwise, said parent string is kept as part of said new population; and

said discriminator processes performance measures include average least squares error for all members of each said population, least squares error for a fittest

member of each said population, and normalized variance of each of physical parameters across a whole population.

16. A method for target detection and identification, as recited in claim 15, wherein said crossover module includes a parent input module, a crossover point determination, a first child generation, a normalization, a second child generation, a normalization, and a child pool, wherein

said parent input module takes said two parent strings from said selection and coupling module, wherein said two parent strings exchange string parts thereof after determination of a crossover point;

said crossover point determination randomly picks up a number between 1 and a total number of endmembers minus 1 as said crossover point;

said first child generation combines a first string part of a first parent string of said two parent strings and a second string part of a second parent string of said two parent strings to form a first child string which is normalized in said normalization that said sum of said abundance equal to 1 and then said normalized first child string is put into said child pool;

said second child generation combines a first string part of said second parent string and a second string part of said first parent to form a second child string which is normalized in said normalization that said sum of said abundance equal to 1 and then said normalized second child string is put into said child pool.

17. A method for target detection and identification, as recited in claim 16, wherein said mutation module comprises a random number generation, a parent input module, a child generation, a normalization, a mean square error calculation, and a survival selection, wherein said parent input module takes said survived strings from said crossover module, wherein said random number generation generates random numbers that, in said child generation, are added to elements of each of said parent strings from said parent input module, and said mutated child from child generation is normalized in said normalization, wherein said mean square error calculation computes said mean

square error corresponding to each of said strings, and said survived child is finally chosen in said survival selection.

18. A method for target detection and identification, as recited in claim 9, wherein said evolutionary estimator comprises a cost function module, an initial population generation module, a selection and coupling module, a crossover module, a mutation module, a fitness evaluation module, and a discriminator, wherein

said initial population generation module creates a predetermined number of initial parent strings of an abundance, wherein a random number generator is utilized to produce uniform numbers between 0 and 1, which guarantees that values of elements of an abundance vector are between 0 and 1 and, in order to make a total abundance of each of said parent strings of abundance equal to 1.0, each of said elements of said abundance vector of each said parent string is normalized, wherein said generated parent strings of abundance are sent to said selection and coupling module;

said cost function module, which is a mean square error, for evaluating a population of said abundance;

said selection and coupling module receives said population of said abundance and selects two of said parent strings based on said cost function module, that is a minimum value of said mean square error, wherein said two selected parent strings are sent to said crossover module to perform crossover operation;

said crossover module chooses a split point for both of said selected parent strings, wherein when said split point is located between a second and third elements, after said crossover, two new strings are created, wherein after crossover, said new strings are normalized to make a sum of said abundances equal to 1, wherein when said new strings are better than any of said parent strings in said population, said new strings replace said two selected parent strings to form survived strings and enter a new population; otherwise, said parent strings are inherited to form said survived strings, wherein said survived strings are sent to said mutation module;

said mutation module mutates each said parent string into a child string by generating –10% to 10% random numbers to add to said elements for each of said parent strings, wherein each of said survived strings is normalized and then sent to said fitness evaluation module;

said fitness evaluation module calculates said mean square error for each of said new strings, wherein when a value of mean square error of said new string is better than that of said respective parent string, said new string goes into said new population as said child string; otherwise, said parent string is kept as part of said new population; and

said discriminator processes performance measures include average least squares error for all members of each said population, least squares error for a fittest member of each said population, and normalized variance of each of physical parameters across a whole population.

19. A method for target detection and identification, as recited in claim 18, wherein said crossover module includes a parent input module, a crossover point determination, a first child generation, a normalization, a second child generation, a normalization, and a child pool, wherein

said parent input module takes said two parent strings from said selection and coupling module, wherein said two parent strings exchange string parts thereof after determination of a crossover point;

said crossover point determination randomly picks up a number between 1 and a total number of endmembers minus 1 as said crossover point;

said first child generation combines a first string part of a first parent string of said two parent strings and a second string part of a second parent string of said two parent strings to form a first child string which is normalized in said normalization that said sum of said abundance equal to 1 and then said normalized first child string is put into said child pool;

said second child generation combines a first string part of said second parent string and a second string part of said first parent to form a second child string which is normalized in said normalization that said sum of said abundance equal to 1 and then said normalized second child string is put into said child pool.

20. A method for target detection and identification, as recited in claim 19, wherein said mutation module comprises a random number generation, a parent input module, a child generation, a normalization, a mean square error calculation, and a survival selection, wherein said parent input module takes said survived strings from said crossover module, wherein said random number generation generates random numbers that, in said child generation, are added to elements of each of said parent strings from said parent input module, and said mutated child from child generation is normalized in said normalization, wherein said mean square error calculation computes said mean square error corresponding to each of said strings, and said survived child is finally chosen in said survival selection.

21. A method for target detection and identification, as recited in claim 12, wherein said evolutionary estimator comprises a cost function module, an initial population generation module, a selection and coupling module, a crossover module, a mutation module, a fitness evaluation module, and a discriminator, wherein

said initial population generation module creates a predetermined number of initial parent strings of an abundance, wherein a random number generator is utilized to produce uniform numbers between 0 and 1, which guarantees that values of elements of an abundance vector are between 0 and 1 and, in order to make a total abundance of each of said parent strings of abundance equal to 1.0, each of said elements of said abundance vector of each said parent string is normalized, wherein said generated parent strings of abundance are sent to said selection and coupling module;

said cost function module, which is a mean square error, for evaluating a population of said abundance;

said selection and coupling module receives said population of said abundance and selects two of said parent strings based on said cost function module, that is a

minimum value of said mean square error, wherein said two selected parent strings are sent to said crossover module to perform crossover operation;

said crossover module chooses a split point for both of said selected parent strings, wherein when said split point is located between a second and third elements, after said crossover, two new strings are created, wherein after crossover, said new strings are normalized to make a sum of said abundances equal to 1, wherein when said new strings are better than any of said parent strings in said population, said new strings replace said two selected parent strings to form survived strings and enter a new population; otherwise, said parent strings are inherited to form said survived strings, wherein said survived strings are sent to said mutation module;

said mutation module mutates each said parent string into a child string by generating –10% to 10% random numbers to add to said elements for each of said parent strings, wherein each of said survived strings is normalized and then sent to said fitness evaluation module;

said fitness evaluation module calculates said mean square error for each of said new strings, wherein when a value of mean square error of said new string is better than that of said respective parent string, said new string goes into said new population as said child string; otherwise, said parent string is kept as part of said new population; and

said discriminator processes performance measures include average least squares error for all members of each said population, least squares error for a fittest member of each said population, and normalized variance of each of physical parameters across a whole population.

22. A method for target detection and identification, as recited in claim 21, wherein said crossover module includes a parent input module, a crossover point determination, a first child generation, a normalization, a second child generation, a normalization, and a child pool, wherein

said parent input module takes said two parent strings from said selection and coupling module, wherein said two parent strings exchange string parts thereof after determination of a crossover point;

said crossover point determination randomly picks up a number between 1 and a total number of endmembers minus 1 as said crossover point;

said first child generation combines a first string part of a first parent string of said two parent strings and a second string part of a second parent string of said two parent strings to form a first child string which is normalized in said normalization that said sum of said abundance equal to 1 and then said normalized first child string is put into said child pool;

said second child generation combines a first string part of said second parent string and a second string part of said first parent to form a second child string which is normalized in said normalization that said sum of said abundance equal to 1 and then said normalized second child string is put into said child pool.

23. A method for target detection and identification, as recited in claim 22, wherein said mutation module comprises a random number generation, a parent input module, a child generation, a normalization, a mean square error calculation, and a survival selection, wherein said parent input module takes said survived strings from said crossover module, wherein said random number generation generates random numbers that, in said child generation, are added to elements of each of said parent strings from said parent input module, and said mutated child from child generation is normalized in said normalization, wherein said mean square error calculation computes said mean square error corresponding to each of said strings, and said survived child is finally chosen in said survival selection.